



# NASA Advisory Council Presentation

## Status of Exploration Systems Development

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Deputy Associate Administrator  
for Exploration Systems Development  
July 29, 2013



- Program Status and Schedule
- SLS PDR
- MAF Update
- EFT-1 Update
- ESA Service Module
- Fairing Separation Video

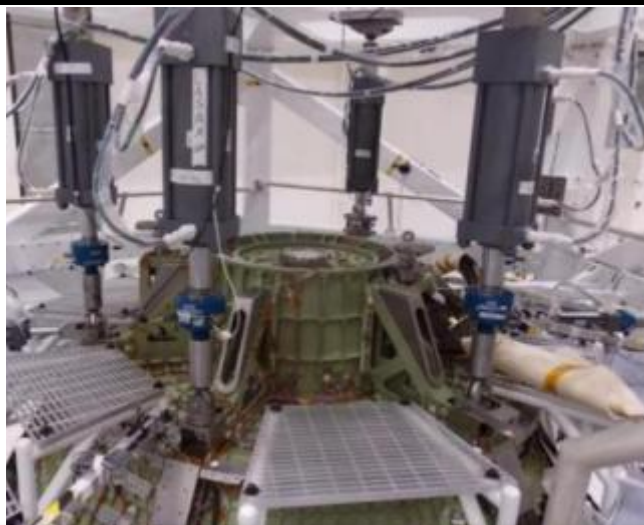


# Exploration Systems Development (ESD) Status and Schedule

# Orion Accomplishments



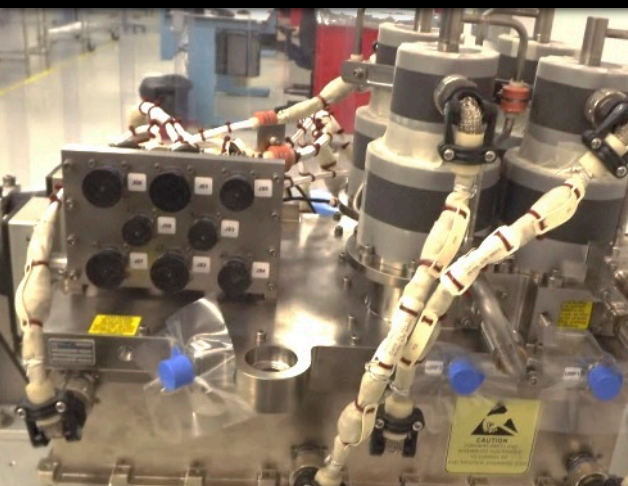
**EFT-1 Crew Module being placed in the Static Loads Test Fixture at the Operations and Checkout Facility**



**Actuators used in the Static Loads Test are attached to the top of the EFT-1 Crew Module**



**Backshell panel drilling**



**Environmental Control and Life Support System – Coolant Pump Package 1**



**Capsule Parachute Assembly System testing at Army Yuma proving ground in AZ**



**Applying the Avcoat material to Orion heat shield – Textron in MA.**



# Orion Accomplishments



**100% of Service Module panels complete and delivered to KSC**



**Launch Abort System static test at the Lockheed Martin facility in Sunnyvale, CA**



**Fairing separation test 1 at Lockheed Martin, Sunnyvale, CA**



**Service Module Environmental Control and Life Support System tube welding**



**Hot Fire Test Article loaded into the test cell at Aerojet facility in CA**



**Power Distribution Unit C1 in Thermal Chamber Box Confidence Testing**



# SLS Accomplishments



**Vertical Weld Tool Complete at Michoud Assembly Facility**



**Vertical Assembly Center Construction begins for the Core Stage production**



**First Trial Barrel Segment Completes Vertical Weld on Core Stage**



**Completed MSA Shell**



**B2 Test Stand Construction**



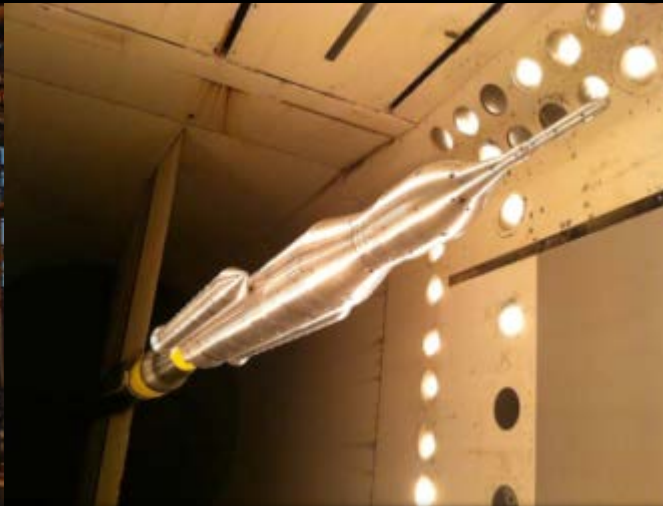
**Flight Computer Engineering Development Unit delivered to MSFC**



# SLS Accomplishments



**F-1B Gas Generator – Tech Demo for Advanced Booster Concept**



**SLS Rigid Buffet Wind Tunnel Model installed in the Transonic Dynamics tunnel at LaRC.**



**Engineers meeting with DFRC personnel about planned Flight test of Adaptive Augmenting Control**



**Completed Flight Control Test #2, Booster Avionics**



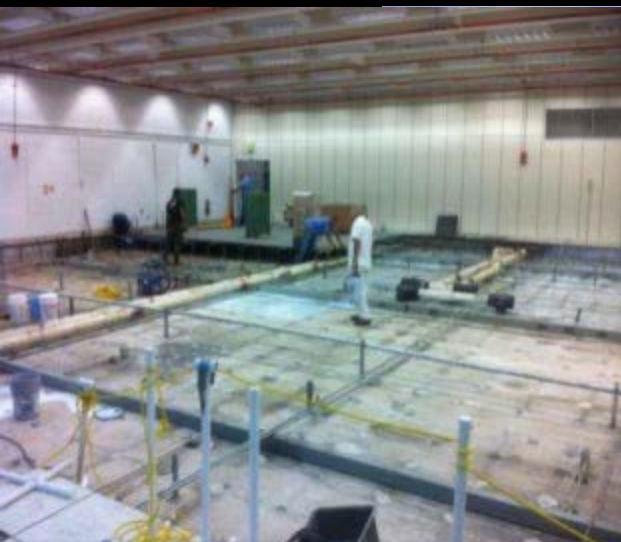
**J-2X Engine 10002 Arrival at Stennis A1 Test Stand**



**Center segment for QM-1 delivered to its test bay at ATK's facility in Utah**



# GSDO Accomplishments



Installation of flooring in the main firing room started – application of floor sealant



Landing and Recovery EIT participated in shipment of the Crew Module Recovery Cradle to Langley Research Center



Demonstration of the “local” display software for the Crew Module Ammonia Servicing System at the Engineering Development Lab



Fabrication of Liquid Oxygen (LO2) Vaporizer that will be installed at Pad B



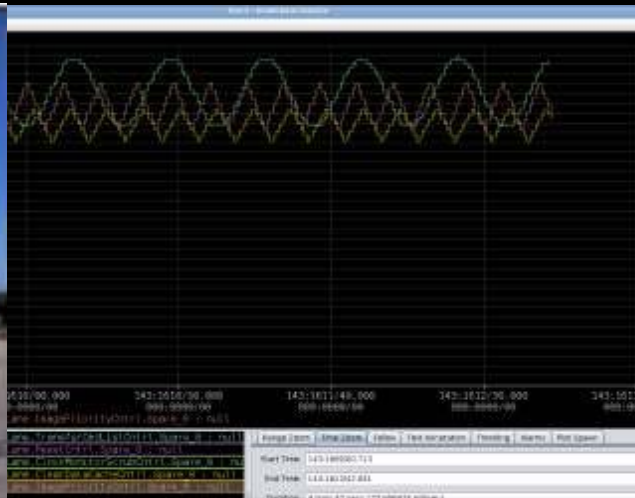
Pad B Flame Trench and Flame Deflector demolition project



Completed Crew Module Recovery Cradle testing



# GSDO Accomplishments



**Installation of the second set of Radio Frequency and Telemetry System antennas**

**Successfully recorded data sent from Customer Avionics Integration Development Analysis lab to Firing Room 1**

**Boilerplate test article Handling Fixture bumper, goalposts, container load trailers, casters, etc. delivered to Langley Research Center**



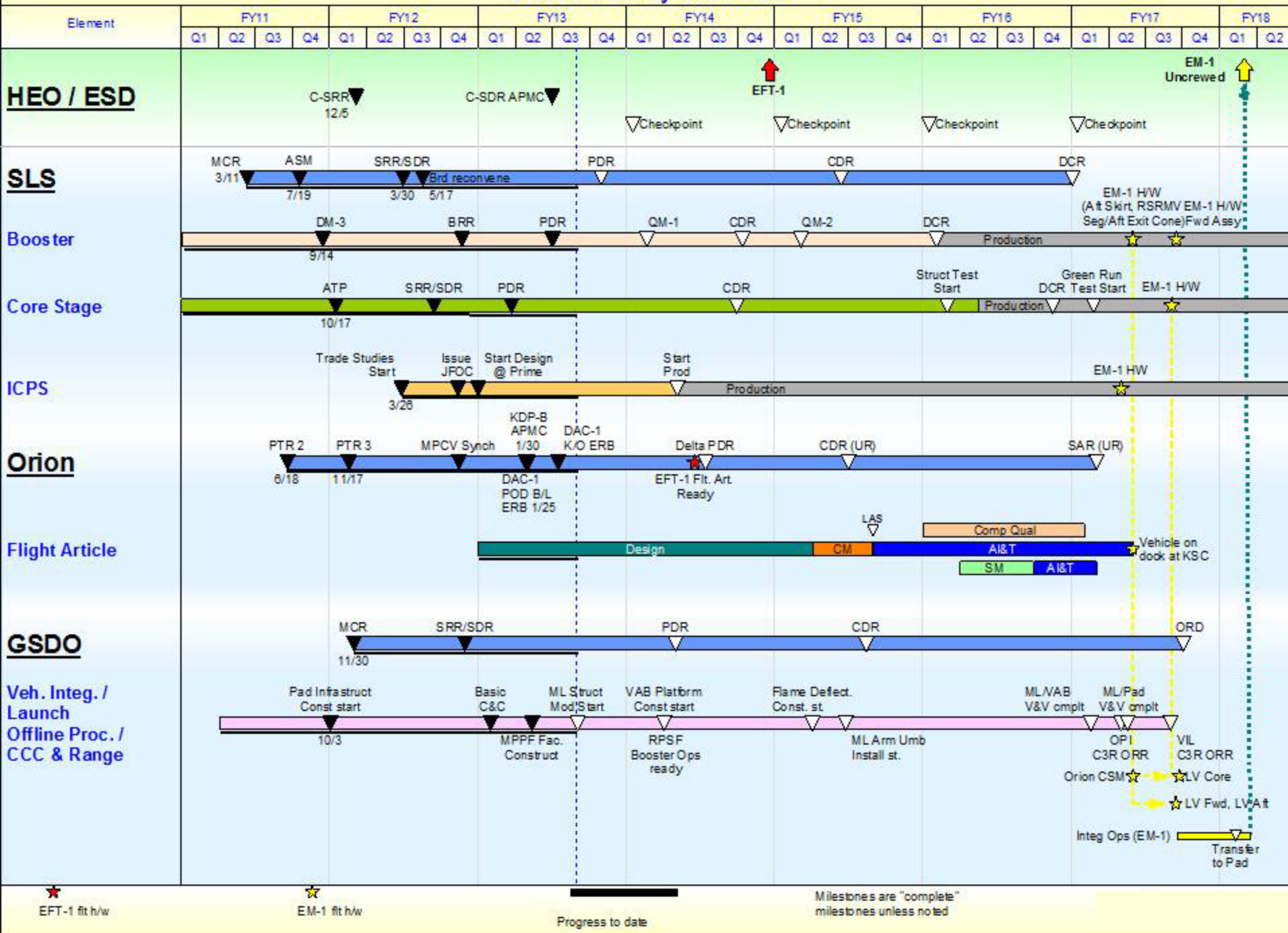
**Completed proof load of the Forward Bay Access Stands on the BTA Handling Fixture**

**Pad 39B Modifications including new hydraulic elevators**

**Facility modifications in the Multi-Payload Processing Facility**

# ESD Summary Schedule

Version: 2013-05-31





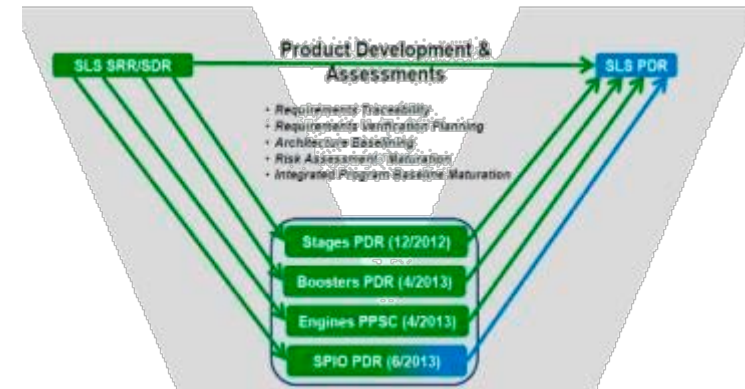


# SLS Preliminary Design Review (PDR) Status

# Space Launch System (SLS) Preliminary Design Review (PDR) Status 25 July 13



- **SLS PDR is on track**
  - SLS PDR Pre-Board: July 24-25, 2013
  - SLS PDR Board: July 31, 2013
- **PDR review teams worked pre-review item discrepancies (pre-RIDs) via tabletops to the RID Integrated Screening Team.**
  - Intent of tabletops was to provide a forum for discussion of SLS's ability to meet the success criteria.
  - Of the 600+ pre-RIDs assessed by the review teams, less than 150 were designated as RIDs by the Integrated Screening Team
- **SLS Board assigns and dispositions RIDs and determines SLS capability to meet success criteria to move fwd to Critical Design Review.**
  - Proposed corrective actions are being generated and assessed by the review teams in preparation for the SLS PDR



#	Success Criteria and Description
1	<b>Requirements Complete &amp; Consistent with Preliminary Design</b> Agreements exist for the top-level requirements, including mission success criteria, TPMs, and any sponsor-imposed constraints, and that these are finalized, stated clearly, and consistent with the preliminary design.
2	<b>Flow Down of Requirements</b> The flow down of verifiable requirements is complete and proper or, if not, an adequate plan exists for timely resolution of open items. Requirements are traceable to mission goals and objectives.
3	<b>Preliminary Design Acceptable</b> The preliminary design is expected to meet the requirements at an acceptable level of risk.
4/5*	<b>Technical Interfaces</b> Definition of the technical interfaces is consistent with the overall technical maturity and provides an acceptable level of risk.
6	<b>Technical Margins Adequate with TPMs</b> Adequate technical margins exist with respect to TPMs.
7	<b>New Technology</b> Any required new technology has been developed to an adequate state of readiness, or backup options exist and are supported to make them a viable alternative.
8	<b>Risks</b> The project risks are understood and have been credibly assessed, and plans, a process, and resources exist to effectively manage them.
9	<b>Safety/Reliability Analysis</b> Safety/Reliability Analyses (e.g., Hazard Analyses, PRA, etc.) meet requirements, are at the appropriate maturity level for this phase of the Program's life cycle, and indicate that the Program (Element) safety/reliability residual risks will be at an acceptable level.
10	<b>Sound Operational Concept</b> The operational concept is technically sound, includes (where appropriate) human factors that apply, and includes the flow down of requirements for its execution flow.

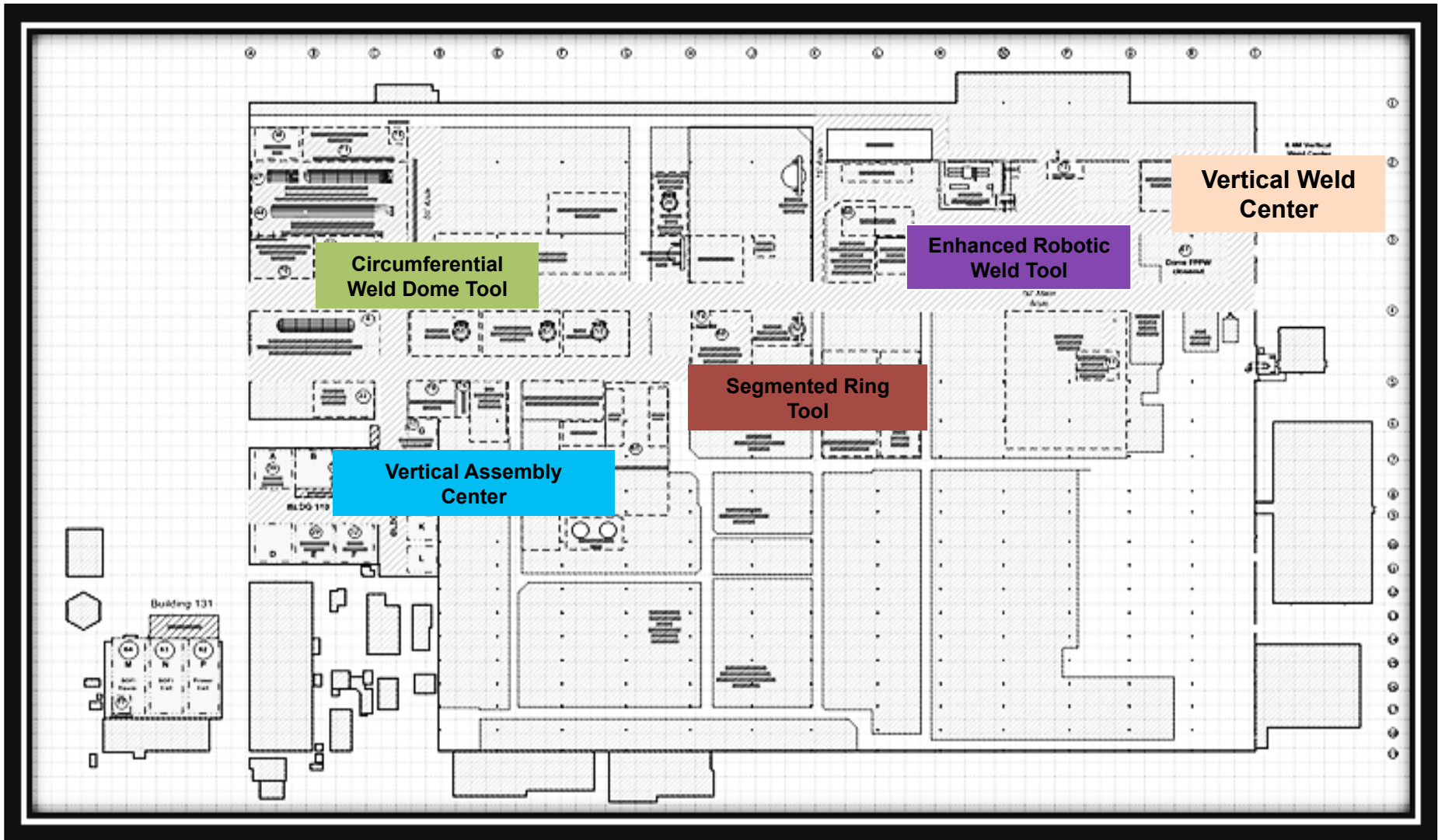
**SLS poised for successful PDR**





# Michoud Assembly Facility (MAF) Update

# Michoud Assembly Facility (MAF), LA

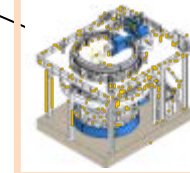
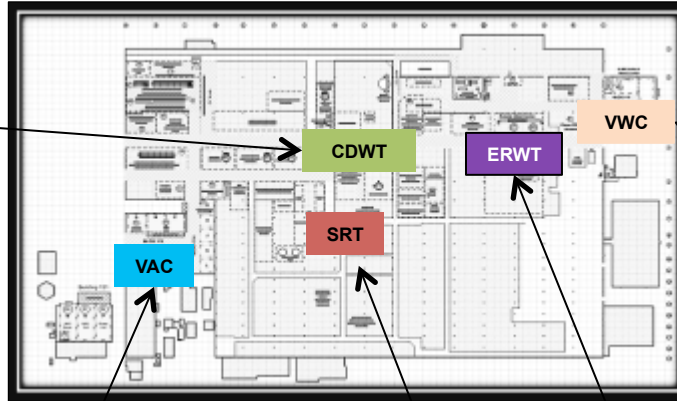




# Stages Manufacturing, Assembly, & Production/Operations Snapshot at Michoud Assembly Facility



Circumferential Dome Weld Tool



Vertical Weld Center (VWC)



Enhanced Robotic Weld Tool (ERWT)



Vertical Assembly Center (VAC)



Segmented Ring Tool (SRT)



# Core Stage Major Weld Tools at Michoud Assembly Facility (MAF), LA



**Segmented Ring Tool (SRT) Installation Complete 2/20/13**



**Enhanced Robotic Weld Tool (ERWT) Installation Complete 4/25/13 (ERWT is turntable under CDWT)**



**Gore Weld Tool (GWT) Installation Complete 4/30/13**



**Circumferential Dome Weld Tool (CDWT) Installation Complete 5/19/13 (on plan)**



**Vertical Weld Center (VWC) Installation Complete 6/10/13 (on plan)**



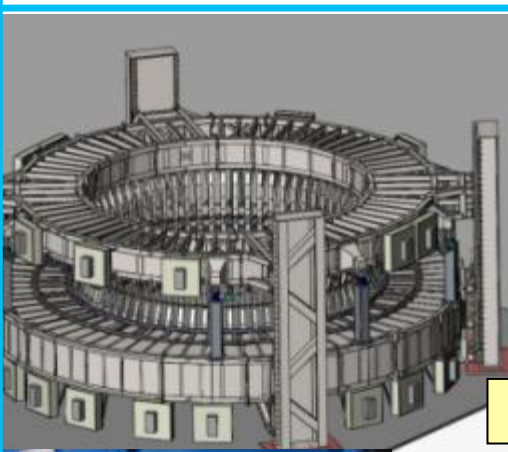
**Vertical Assembly Center (VAC) Foundation Complete 7/1/13 (under review)**





# VAC Tool Progress at Michoud Assembly Facility

## Installation Complete Spring 2014 (on plan)



**Tower Installation at vendor checkout**



**Left In-Feeder – Screw Assembly Installation**



**Electrical Assembly and Test Setup In Work**



**VAC Upper Clamp Ring (UCR) – Final Segment Installation**





# Vertical Weld Center (VWC) at Michoud Assembly Facility Status



- VWC will weld barrel panels together to produce whole barrels for SLS's core stage
- VWC stands about three stories tall and weighs 150 tons
  - Opened on June 21st
- Core stage, towering more than 200 feet (61 meters) tall with a diameter of 27.6 feet (8.4 meters), will store cryogenic liquid hydrogen and liquid oxygen that will feed the vehicle's RS-25 engines
- Core Stage consist of two pressurized tanks, the intertank, the forward skirt, and the aft engine section.



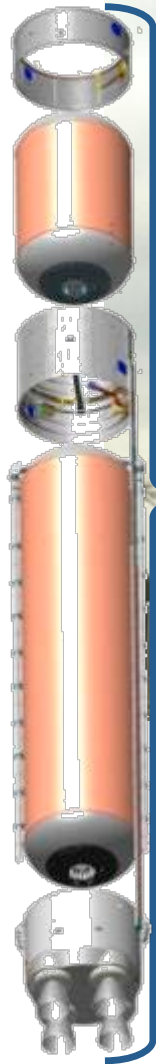
**Completes First Confidence Barrel Weld!**

# SLS Stages “Green Run” Test Buildup

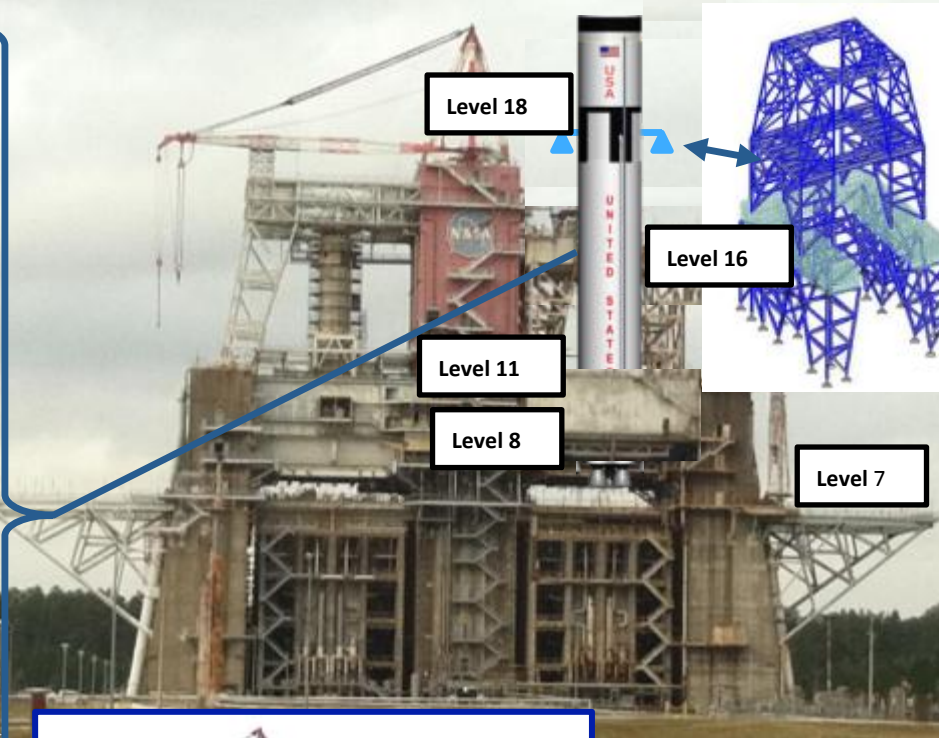
## NASA Stennis Space Center, MS Test Stand B-2



Stage is  
211' Tall



Upper Superstructure



Above: Level 16  
Demolition

Left: Installation  
of Aspirator  
Girders at Level 7



Below: Level 7  
Rolling Deck  
Parts Staged in  
Laydown Yard at  
SSC



Left: Test  
Stand B-2  
Draping for  
Demo and  
Refrurb





# EFT-1 Update



# Orion Testing: Entry, Descent, and Landing



Test completed July 24<sup>th</sup>

- The test marked the first time using the LM Provided parachute compartment which includes riser cutters, and was the first time the Parachute Test Vehicle (PTV) / CPAS PTV Separation System (CPSS) will be extracted from an aircraft at 35,000 ft (as opposed to 25,000 ft) to reach more flight like environmental conditions.
- The test included additional test objectives of obtaining aerodynamics data through flush air data system development flight instrumentation and obtaining performance characteristics of the Orion GPS Receiver.



Parachute test, Yuma, AZ, 12/2012

- Risk-reduction testing for parachutes, splashdown, and recovery operations.
- Orion shares test result data with CCDev2 and its partners, leveraging investment in common suppliers base.



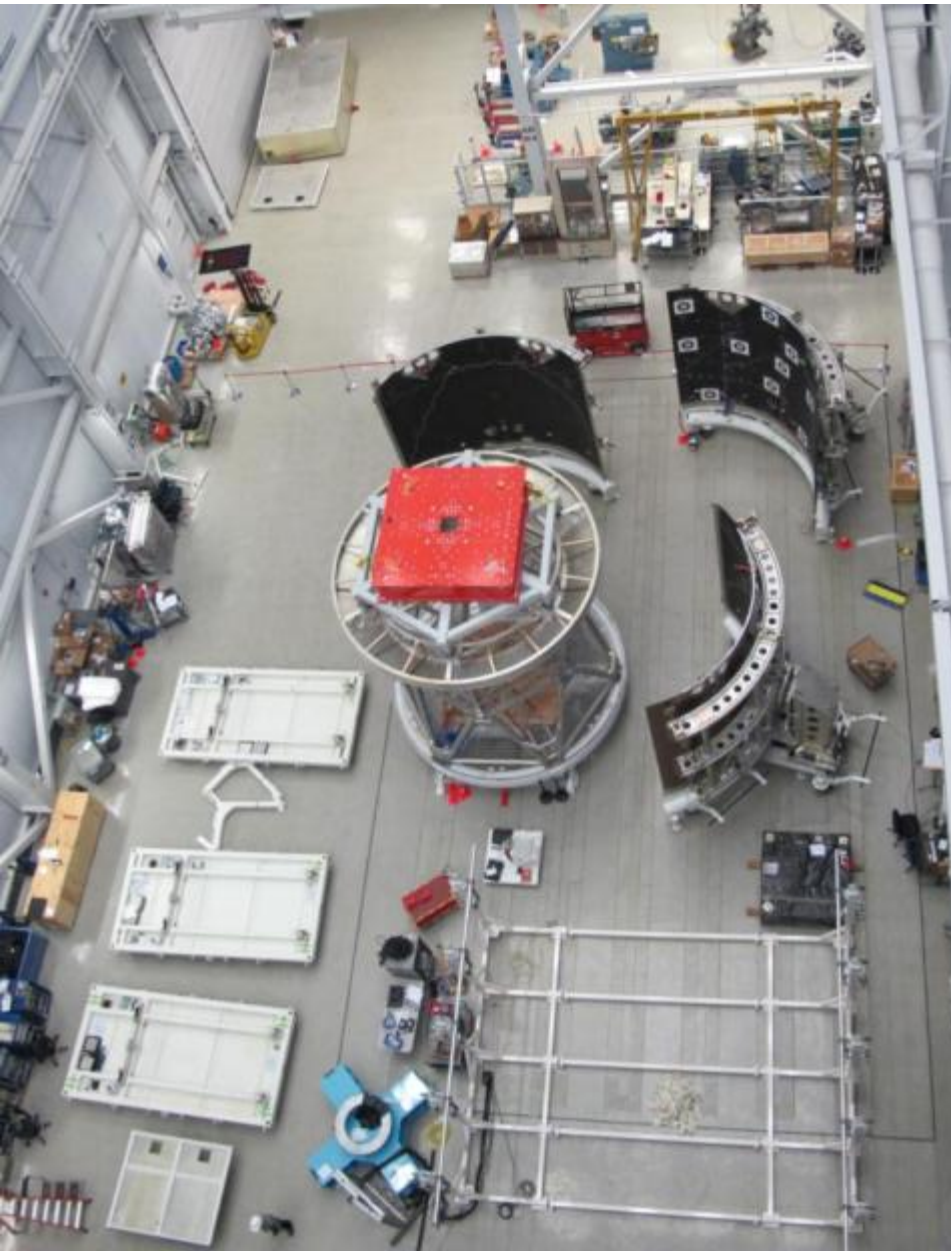
Joint Orion/GSDO/Navy recovery testing, 12/2012

# Heat Shield Honeycomb Coating Application- Textron





# Spacecraft Adapter Jettisonable Fairings First Jettison Test Complete

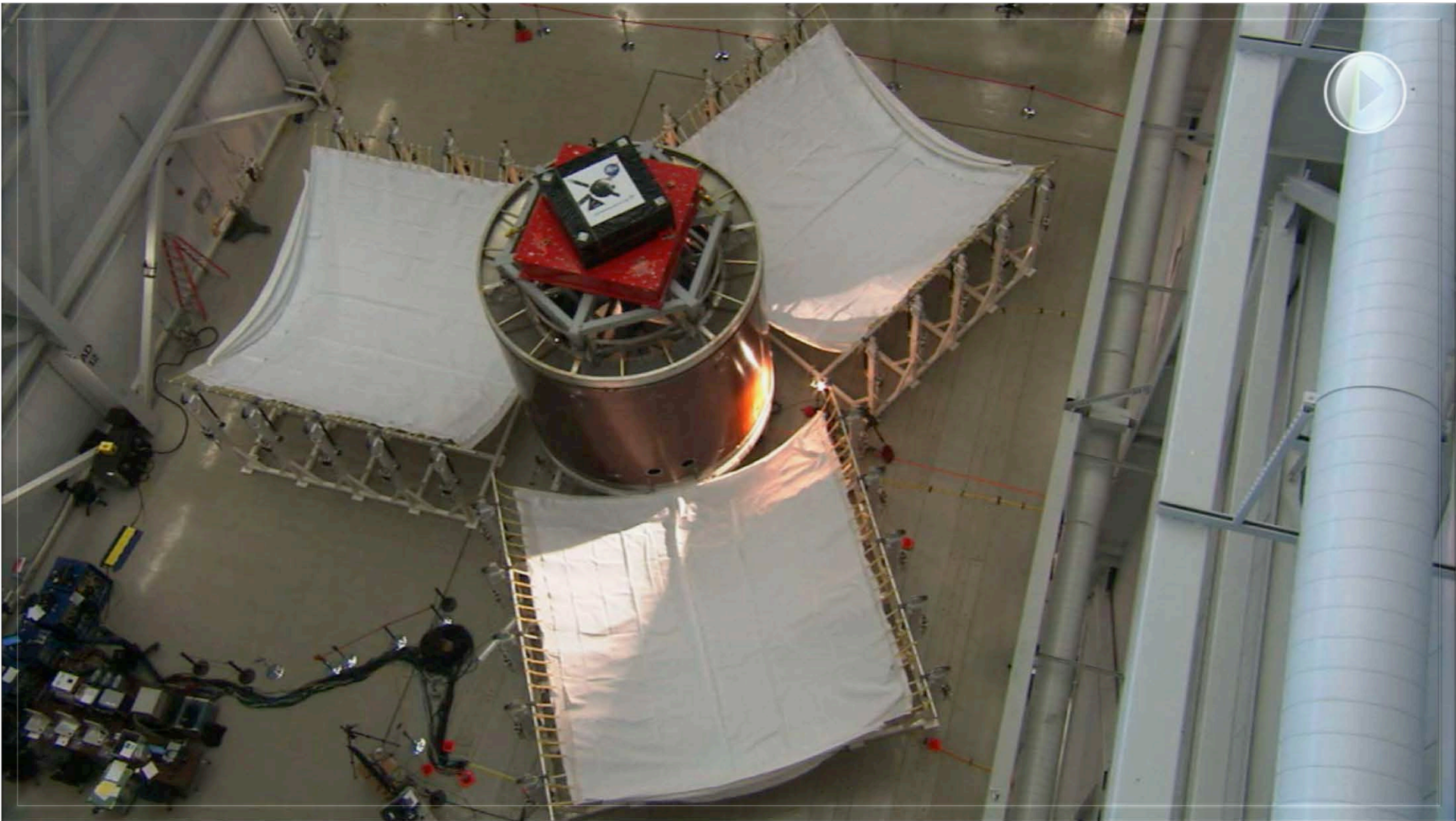




# Fairing Separation – Side View



# Fairing Separation – Overhead View



- NASA continues to make great progress with SLS, Orion and GSDO
  - SLS PDR underway
  - GSDO preparing for PDR early 2014
  - Orion on track for EFT-1 in 2014
- SLS, Orion, and GSDO programs remain on track for 2017